gametophyte), and the term vegetative to those methods which produce the same phase again.

Furthermore, a classification which brings together seeds and spores, as the proposed scheme does under the term *Keime*, will be as prolific of misconception as their frequent comparison has ever been.

We become early suspicious of the book when we find the author postulating a species as an entity. How can anyone who has studied plants write such a sentence as this: "Nun aber ist der Natur nur an der Erhaltung der Species gelegen und die Individuen dienen nur um die Idee der Species in der Welt der Erscheinungen zu repräsentiren!" Much confusion of ideas appears in the frequent comparisons drawn between the gametophytes of the lower plants and the sporophytes of the higher; even the "flowers" of mosses and the flowers of seed plants are compared! Among other curiosities we find definition of an individual: " . . . . ein Körper, der sich nicht theilen lässt und zwar so, dass die Theilung unmittelbar zwei oder mehrere neue vollständige Körper ergibt." How would Möbius apply this to such a plant as Caulerpa? Or to almost any thallophyte for that matter?

The impression that the book leaves is that the author has endeavored to assimilate modern ideas of morphology without complete success; that these ideas have opened out to him visions of possible coordination of facts which he has not yet thought through to their logical outcome; and that he has allowed obsolete views of the relations of the flowering plants to the lower ones to distort his newer conceptions. Among the latter there are some of value, but they are not new nor are they presented with sufficient clearness to make the book one of any real importance.—C. R. B.

NOTES FOR STUDENTS.

KLEBAHN has continued his studies on zygotes with the investigation of the auxospore formation in a diatom, *Rhopalodia gibba* O. Müller.[7] In this species the process involves an undoubted sexual act in the copulation of gametes of separate origins. The mother cells of the gametes are very commonly of unequal size. They become attached to each other side by side, and the nucleus of each divides first into two and then into four daughter nuclei, of which two remain small. Each mother cell then divides by constriction transversely in such a way that the daughter cells each contain two nuclei, one large, the other small. These daughter cells are the gametes, and they fuse in pairs, one gamete of each fusing pair being derived from each of the two mother cells. The small nuclei have generally disappeared during fusion. The so formed zygotes then grow out at right angles to the long axes of the mother cells and form auxospores. The large nuclei fuse quite late in

[7] "Beiträge zur Kenntniss der Auxosporenbildung, I. *Rhopalodia gibba* (Ehrenb.) O. Müller." Jahrb. für wiss. Bot. **29**: Heft 4. 1896.

the development of the auxospore. The process of conjugation here also, as in the desmids Closterium and Cosmarium, involves the formation of supernumerary nuclei, but these are formed in the diatom before conjugation instead of after as in the desmids. The resemblance of the process in Rhopalodia to the formation of supernumerary nuclei in copulating infusorians, and to the formation of polar bodies in animal eggs is quite close. The author is also of the opinion that twice as many chromosomes appear in ordinary vegetative divisions as in the two ripening divisions, and that just before the latter a reduction in the number of chromosomes may occur. The smallness of the nuclei, however, and the few cases where mitosis was observed, leave this question in doubt.— R. A. H.

IN THE *Berichte der deutschen pharmaceutischen Gesellschaft* for the current year (p. 11) there appears a short paper by Carl Müller of Berlin concerning the inclusions in the living cell wall. He announces the discovery in the wall of certain cells in the root of *Spiræa filipendula* of crystal like masses which gave none of the reactions of calcium oxalate or calcium carbonate, but on the contrary all those of cellulose. He concludes, therefore, that these crystalline masses are cellulose, and thinks that their occurrence is very general.— L. S. C.

UNDER the title of *Sclerotinia heteroica*[8] M. Woronin and S. Nawaschin give the completed account of their discovery of a heterœcious ascomycete. The two forms in which the fungus appears are the saucer shaped long stalked apothecium, which develops from a sclerotium enclosed in a mummified fruit of *Ledum palustre*, and the conidial form whose mycelium develops in leaves and twigs of *Vaccinium uliginosum*. The ascus fruit had been already described by Nawaschin, as *S. ledi*.[9] The conidial fruit was first obtained in cultures on nutrient gelatine and its discovery in this way led to the supposition that it might occur in nature on leaves of the same host plant as is the case with *Sclerotinia megalospora*, whose conidia and apothecia are both parasitic on *Vaccinium uliginosum*. No conidial form, however, could be found on Ledum, but the discovery was made that what has previously been known as the conidial fruit of *S. megalospora* consists really of two forms widely distinct from each other; one of which, as was proved by artificial infections, is able to produce sclerotia only in the ovaries of the Vaccinium; while the other can infect only those of Ledum. The two conidial forms differ further in the size of their spores, in their effect on the host plant, in their manner of germinating in water, and especially in their manner of penetrating to the ovary of the host plant. Infection in both cases takes place through

[8] Zeitschrift für Pflanzenkrankheiten—:—. 1896. [Heft 3–4. *pl. 3, 4.*]

[9] Über eine neue *Sclerotinia* vergleichen mit *S. rhododendri* Fischer. Berichte d. deutsch. bot. Ges. **12**:—. 1894. [Heft. 5.]

the stigma at the time of pollination. In *S. megalospora* each conidium produces a germ tube which grows independently down through the style to develop the mycelium in the ovary, while in *S. heteroica* the germ tubes of a number of conidia fuse to form a single much stronger hypha, which then penetrates downward through the style. This anastomosing of germ tubes has also been observed by the authors in *S. padi* and *S. aucupariae*, and furnishes a further interesting example of a fusion of protoplasmic masses which cannot be regarded as having a sexual significance in the ordinary sense. The life history of *S. heteroica* is as follows: The capsules of Ledum are infected through the stigma. The mycelium forms in the ovary a sclerotium which germinates and forms a single stalked ascus fruit in the following May. The ascospores are carried by the wind to the unfolding leaves of *Vaccinium uliginosum*, in which they develop a mycelium which produces the pustules of conidiospores a few weeks later.

Heteroecism has so far been observed only in the Uredineæ, and its discovery among the ascomycetes is of great interest, as suggesting that various *fungi imperfecti* may be connected with ascocarpous forms in this way.—R. A. H.

THE PRELIMINARY NOTICES concerning the structure and cytology of the Mucorineæ by MM. Léger and Dangéard, which have appeared in *Comptes Rendus* and in *Le Botaniste* during the past few years, have been followed by the extended paper of the former author,[10] in which he describes at considerable length the phenomena observed, and illustrates the same by twenty-one photo-process plates. The cytology, development of the sporangia, conidia, zygospores, etc., were studied in the following genera: Sporodinia, one species; Rhizopus, one species; Mucor, four species; Chaetocladium, two species; Thamnidium, one species; Pilobolus, two species; Pilaria, one species; Mortierella, two species; Syncephalis, one species; Pitocephalis, one species; and were found to be strikingly uniform throughout the series of forms investigated. The nuclei, which the author found most readily demonstrated by the use of Böhmer's hæmatoxylin acidulated with acetic acid and allowed to act for from one to five days, are present in the hyphæ in great abundance, are variable in size (.5–5μ in diameter), having a central deeply staining nucleolus surrounded by a peripheral layer which does not stain, the whole enclosed in a nuclear sac. The vegetative nuclei always divide directly, mitotic divisions only occurring in the spores at the period of germination. The conidia result from the more or less simultaneous separation of the contents of the sporangia into polygonal masses, separated from one another by a layer of intersporal non-granular protoplasm which ultimately forms the matrix in which the mature spores are imbedded. Each polygonal mass

[10] LÉGER, MAURICE, Recherches sur la structure des Mucorinées. Pp. 1–150. 21 plates. Poitiers, E. Druinaud. 1896.

contains several nuclei, and after surrounding itself with a wall becomes a spore. According to the author the process of spore formation in the Cephalideæ corresponds in all respects to that in forms characterized by sporangia of the ordinary type, and the homology between the spore rows of this section of the mucors and typical sporangia, which was first maintained by Van Tieghem in his well known memoirs, is thus considered to be fully substantiated.

The most important portion of the paper is that which deals with the nuclear history of the process of conjugation, which was studied in a limited number of the species mentioned, and the subsequent history of the zygospore up to the time of its germination. The young zygospore is said to contain sometimes thousands of nuclei derived from each gamete, and as the spore matures these nuclei gradually disappear. As soon as the last have disappeared two groups of bodies make their appearance at each end of the spore. These bodies, to which the author gives the name "embryogenic bodies," appear to be derived from the nuclei which have disappeared; though they are not formed nuclei, consisting of naked masses of protoplasm, doubtless nuclear in its nature. The embryogenic bodies later fuse in each group. The two resultant masses, which thus replace the groups, are called embryogenic spheres, and having surrounded themselves with two distinct walls constitute the "spheres embryonaires" of the mature zygospore. When the spore is about to germinate these spheres lose their walls, unite to form a single central mass in which numerous nuclei then make their appearance, which, after a single mitotic division, pass out into the hypha of germination. In the formation of the azygospores the history is exactly the same except that there is but one group of embryogenic bodies, and consequently but one embryonic sphere in the mature spore. The author considers the union of the embryogenic bodies as representing a sexual union, and for this reason holds that the azygospores are as truly sexual spores as the zygospores themselves. The phenomenon of conjugation is thus held to be a matter of secondary importance and not sexually significant in the group. To one who is not inclined to attribute sexual significance to all nuclear fusions the question naturally occurs in this connection whether the final union of the embryonic spheres may not represent a sexual union rather than that of the embryogenic bodies, the nuclear material of which may perhaps have been derived in either group from the same gamete; the delay in the fusion of the former finding a parallel in the nuclear history of the zygospore of Basidiobolus.

It may be mentioned that of the forms investigated in the paper two species of the genus Mucor are described as new; one *M. rigidus* being closely allied to *M. mucedo*, while the other, *M. rubescens*, is remarkable for the bright red color of its sporangia.—R. T.

MR. EDWARD C. JEFFREY, of the University of Toronto, makes some preliminary announcements[11] in respect to the prothallus of *Botrychium Virginianum* that are of interest. He has been fortunate enough to obtain several hundred specimens in various stages of development, and thinks that he can soon fill in the gaps in our knowledge of the life history of this plant. The full account of the development of the gametophyte is to appear shortly in the Transactions of the Canadian Institute.

The largest prothalli were 18^{mm} long. They are monoecious, the antheridia being found upon well defined median ridges, and the archegonia upon their sloping sides. An abundant endophytic fungus, similar to a sterile Pythium, is common in the oil bearing tissue on the ventral side of the prothallus. It makes its way from the prothallus to the exterior through the root hairs.

Mr. Jeffrey confirms Campbell's account of the endogenous structure of the antheridia. A superficial cell divides by a periclinal wall into an outer and an inner cell. The latter gives rise to a mass of spermatozoid mother cells. The spermatozoids are of the usual fern type, spiral in form and remarkably large. The archegonium has a long neck made up of four tiers of cells, and projects above the surface of the prothallus. There are points in its development and internal structure that remind one of Marattia.

The oospore divides into octants after the usual manner, but Mr. Jeffrey has been unable to derive the root, stem and first leaf ("cotyledon") from definite octants. The "cotyledon" appears above ground the first year, and after that one leaf is put forth each season. Prothalli have been found attached to six year old sporophytes, which illustrates the great longevity of the gametophyte. It is not unusual to find two sporophytes attached to a single prothallus.— B. M. D.

[11] JEFFREY, E. C. The gametophyte of *Botrychium Virginianum*. Proc. Canadian Institute, 1896.